



PIER Energy-Related Environmental Research

Environmental Impacts of Energy Generation, Distribution and Use

Effects of Global Climate Change on Building Energy Consumption and Its Implications for Building Energy Codes and Policy in California

Contract #: 500-020-004; UC MR-069-04; MEX-07-04

Contractor: Lawrence Berkeley National Laboratory

Contract Amount: \$75,000

Contractor Project Manager: Peng Xu and Philip Hayes

Commission Project Manager: Gina Barkalow

Commission Contract Manager: Beth Chambers

The Issue

Global climate change is making California's mild Mediterranean climate significantly warmer, and a substantial impact on building energy usage is anticipated. Recent work by Huang¹ has estimated that, by the end of this century, energy use for space cooling in Los Angeles will increase by as much as 420% in residential buildings and 31% in commercial buildings, averaged over the four global climate change scenarios developed by the Intergovernmental Panel on Climate Change (IPCC), while heating will go down by 62% and 24%, respectively. Electricity used for cooling will increase and gas used for heating will decrease, yielding a net increase in energy use of 25% to 28% for space conditioning Los Angeles residential and commercial buildings. In addition, changing patterns of extreme weather events, such as the intensity, persistence, and extent of heat waves, will have a significant impact on peak electricity demand for cooling. The increase in extreme days was shown to result in peak energy demand that may result in shortages.

California's summertime peak energy demand "1-in-10 likelihood" currently results in energy shortages. Projected energy demand for the next 10 years indicates California will need to rely on external energy sources during peak energy demand periods due to heat extremes (see figure on next page).

Studies to date on building cooling and energy demand have been based on simplified analyses using constant increases in annual average temperature or changes in cooling degree-days. These results may be inaccurate and insufficiently detailed regarding the climate change impacts of different building energy technologies. For example, the lack of information on changes in humidity, diurnal temperature swings, and solar radiation makes it impossible to assess the impact of climate change on the use of low-energy cooling systems such as natural ventilation, evaporative cooling, night cooling, etc.

¹ Huang, Y.J. 2006. *The Impact of Climate Change on the Energy Use of the US Residential and Commercial Building Sectors*. LBNL report, Lawrence Berkeley National Laboratory, Berkeley, CA.

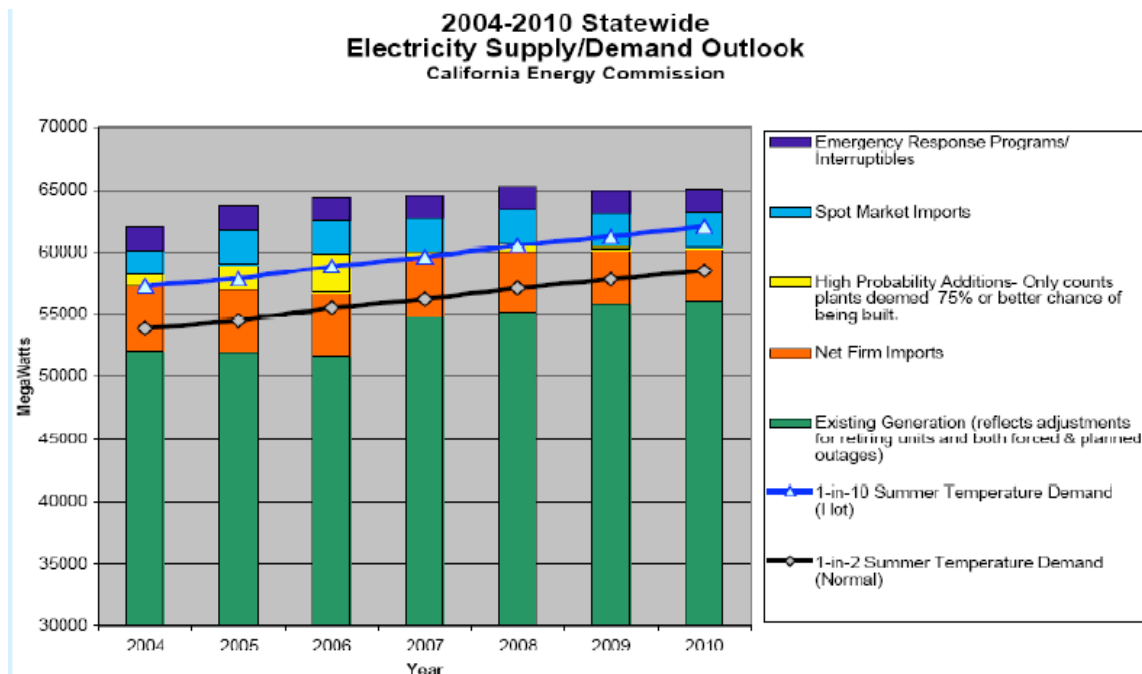


Figure 1. Electricity usage and projection

Project Description

Funded by PIER's Exploratory Environmental Grants Program, this research aims to use the latest global climate and building energy models to study the impacts of global climate change on building energy use in California. Recent improvements in global and regional climate modeling will be combined with detailed building energy simulations to study the impacts of climate change with much greater detail and discernment. The research team will examine the implications of these impacts for building design and energy policy, such as building energy standards and voluntary energy efficiency programs. A general question is whether climate change effects should be incorporated into Title 24 standards, which are currently based on analyses using historical climate data.

Central questions to be addressed are:

- How will climate change affect building cooling and heating energy consumption?
- How will climate change affect electrical peak demand in different regions, as well as in the entire state?
- How will climate change affect the usage of traditional HVAC systems, low-energy cooling systems, and other unconventional HVAC systems?
- How will climate change affect the effectiveness of existing building codes in California?

To answer these questions, the research team will complete the following tasks:

- Create modified hourly weather predictions for the 16 California climate zones under four IPCC carbon scenarios.
- Develop prototypical models of future residential and commercial buildings in California.

- Estimate future residential and commercial building stocks in the state.
- Use the building models to simulate building heating and cooling energy consumption.
- Estimate the aggregated energy usage of future California residential/commercial buildings.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objectives:

- **Provide environmentally sound energy.** Improving the accuracy of building energy usage forecasts will facilitate better building codes and more efficient space cooling, with a concomitant reduction in emissions of greenhouse gases and criteria pollutants.
- **Provide reliable energy.** Grid overload caused by excessive demand from buildings can result in blackouts that cost the economy billions of dollars. More accurate forecasting of the probable electricity use and peak demand in different regions of the state will increase overall electric reliability—with resulting savings to businesses and state tax revenues.
- **Provide affordable energy.** Better building codes and improved engineering practices to accommodate climate change will reduce overall electricity consumption and thus reduce consumer utility bills.

Final Report

PIER-EA staff intend to post the final report on the Energy Commission website in fall 2008 and will list the website link here.

Contact

Gina Barkalow • 916-654-4057 • gbarkalo@energy.state.ca.us